风机性能与系统效应

Fan Performance and System Effect

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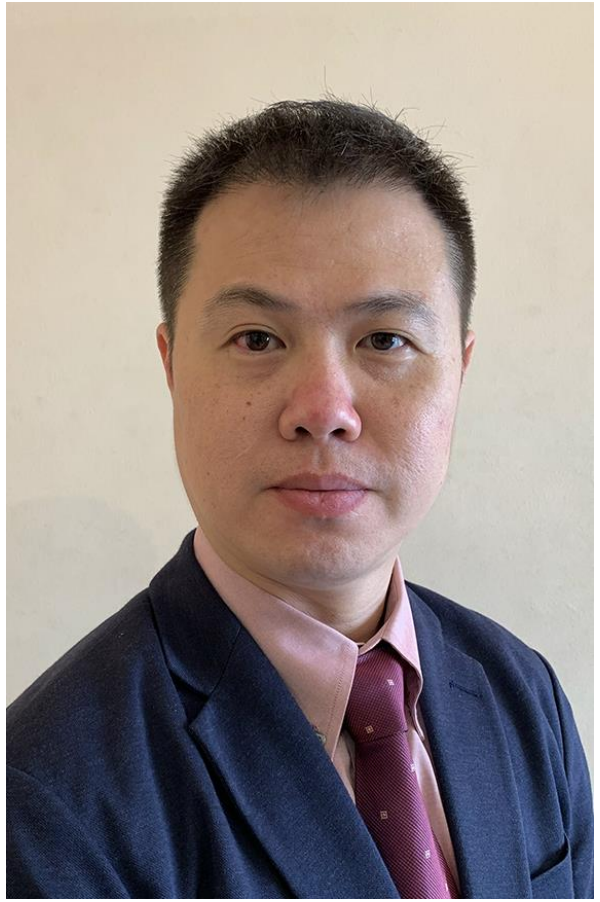
Asia AMCA 市场经理
网路研讨会主持人

- 2013 年加入 Asia AMCA
- 负责亚洲区 AMCA 会员与营销活动



参与准则

- 网络研讨会期间，观众将被静音。
- 可以随时通过 GoToWebinar 平台提交问题，并将在演讲结束时进行解答。
- 提醒： 此网络研讨会被录制！
- 网络研讨会后的评估表将在一天之内通过电子邮件发送给所有人，请您在评估后发回给 AMCA。

问题和解答

提交问题：

- 从屏幕侧面的与会者面板中，选择“问题”下拉选项。
- 在框中输入您的问题，并将演讲者的名字输入在问题的前方。
- 点击“发送”。

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陈跃

亚洲AMCA中国区域的代表

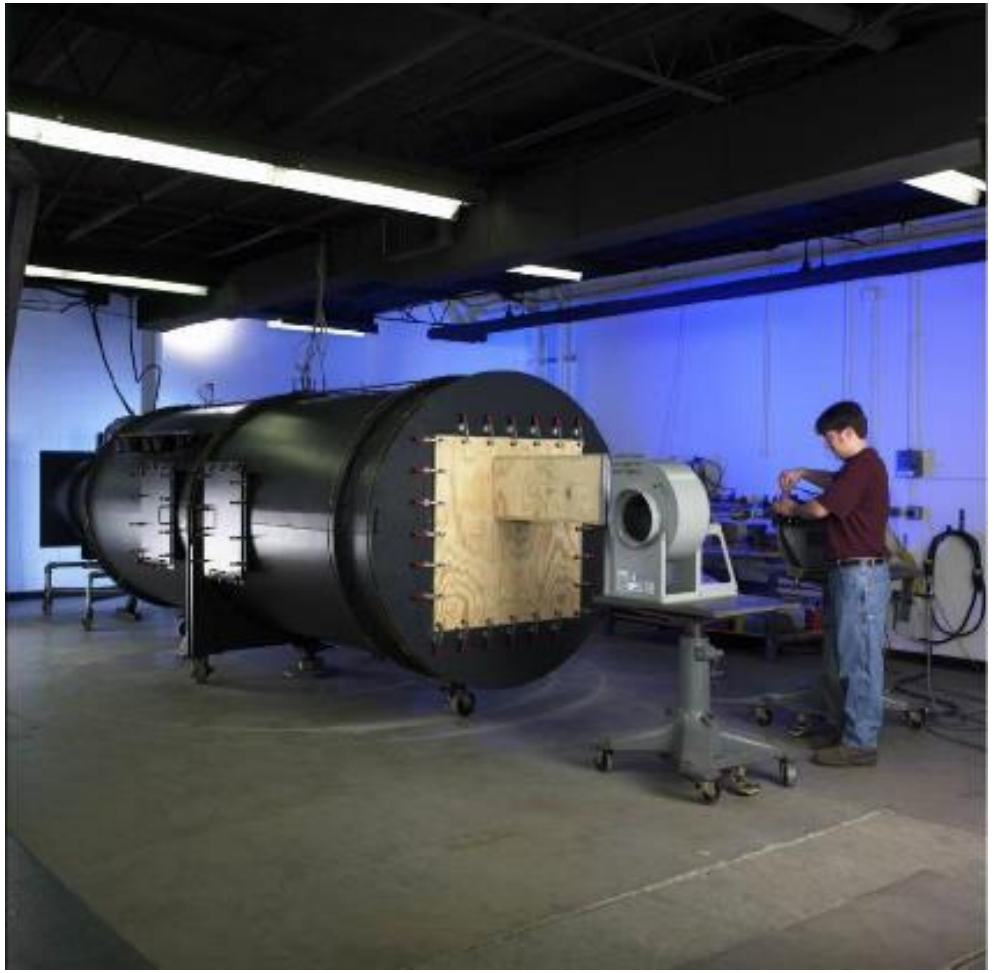
- 2018 年加入Asia AMCA, 协助负责AMCA在中国区域的推广工作。
- 26 年的通风行业经验，历任销售经理、销售总监直至2016年退休。

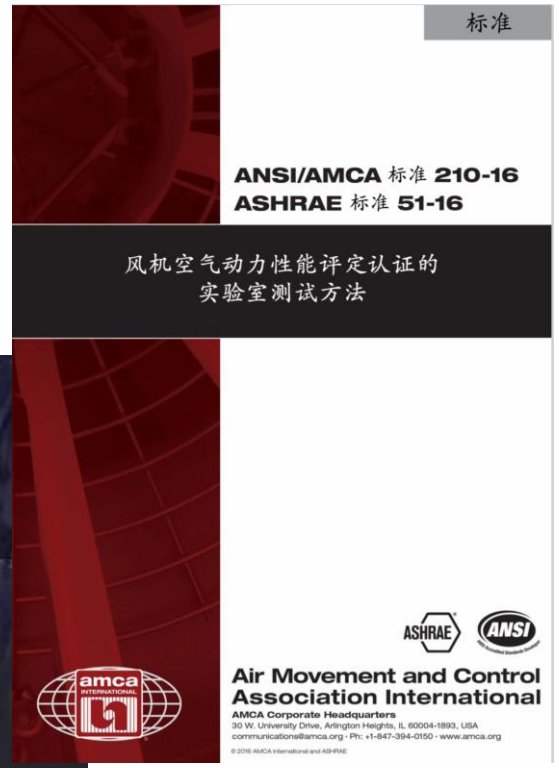
风机测试类型

Fan Installation Type

AMCA建议依据设备实际运行状态进行检测

风机在实验室的测试方法

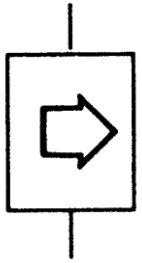




风机测试的配置

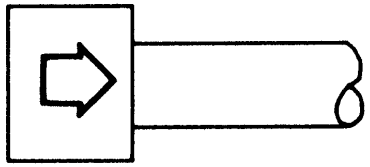
型式A

自由进风，自由出风



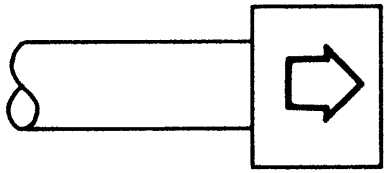
型式B

自由进风，管道出风



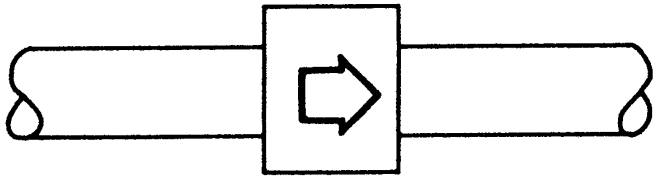
型式C

管道进风，自由出风



型式D

管道进风, 管道出风



典型的商用通风系统

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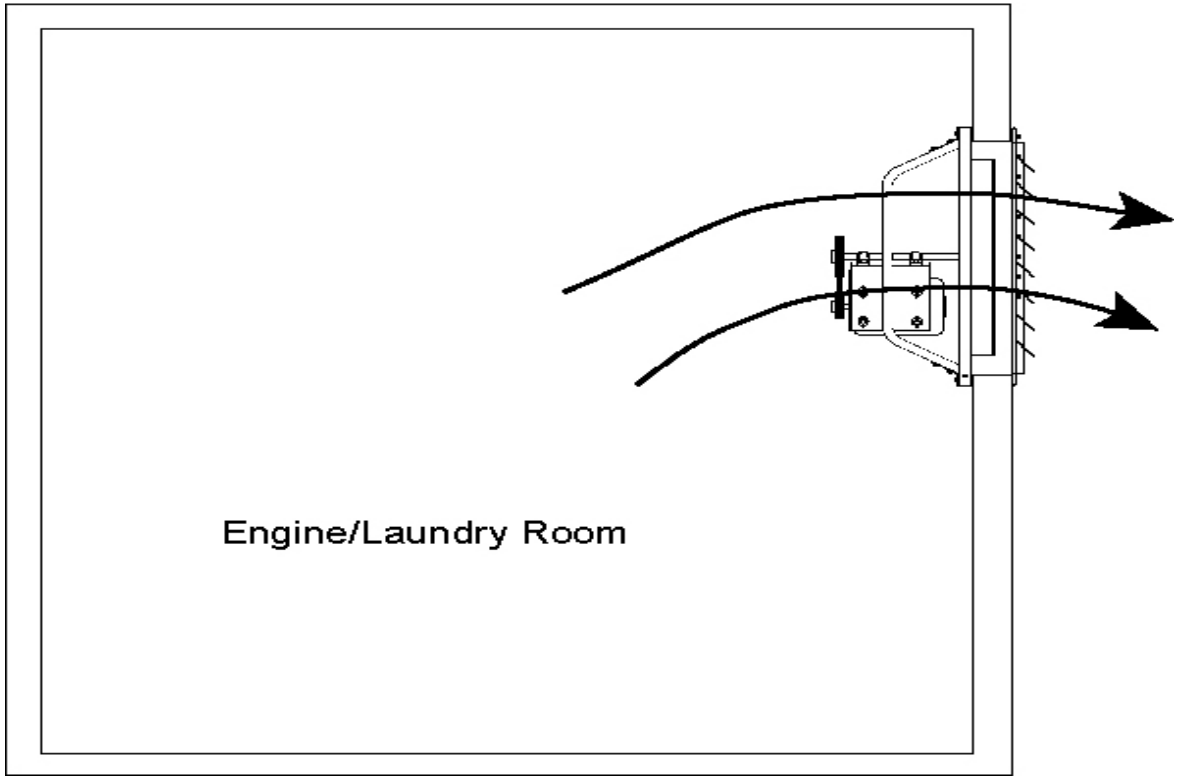
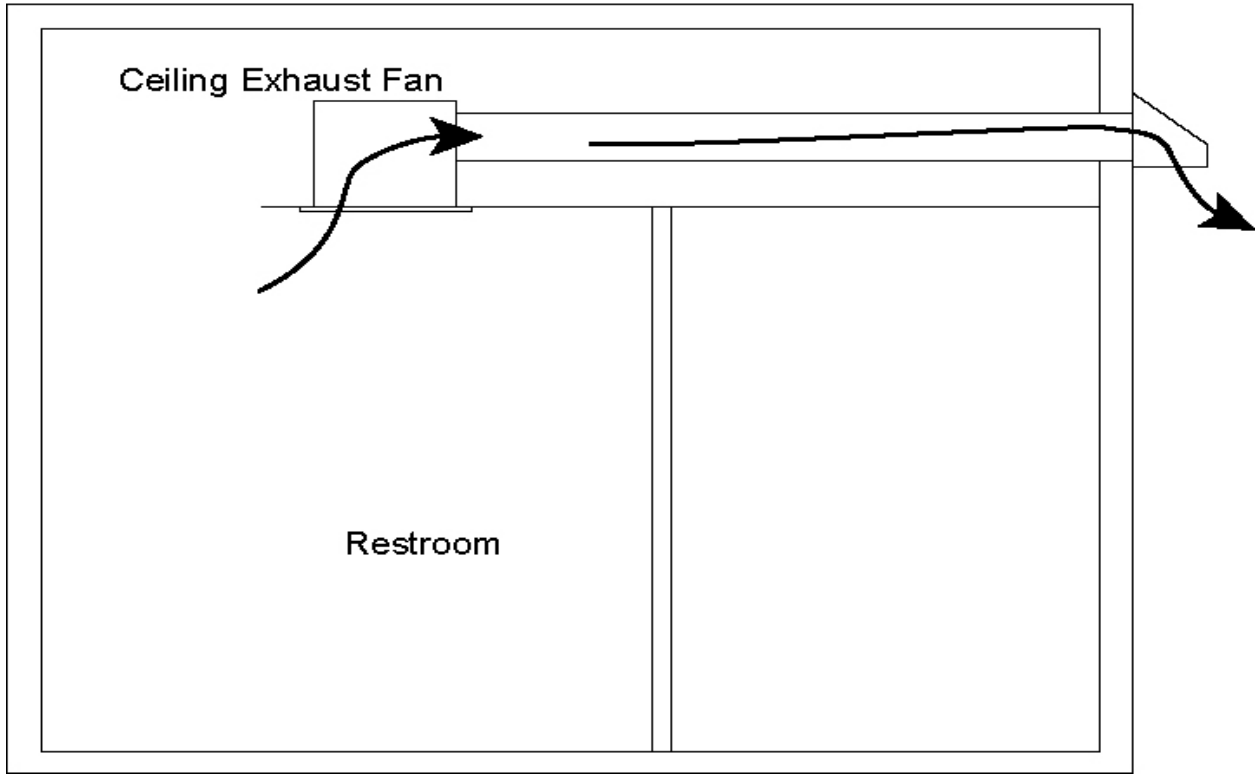
开放式进风，开放式出风 (Type A)



典型的商用通风系统

开放式进风，管道式出风 (Type B)



典型的商用通风系统

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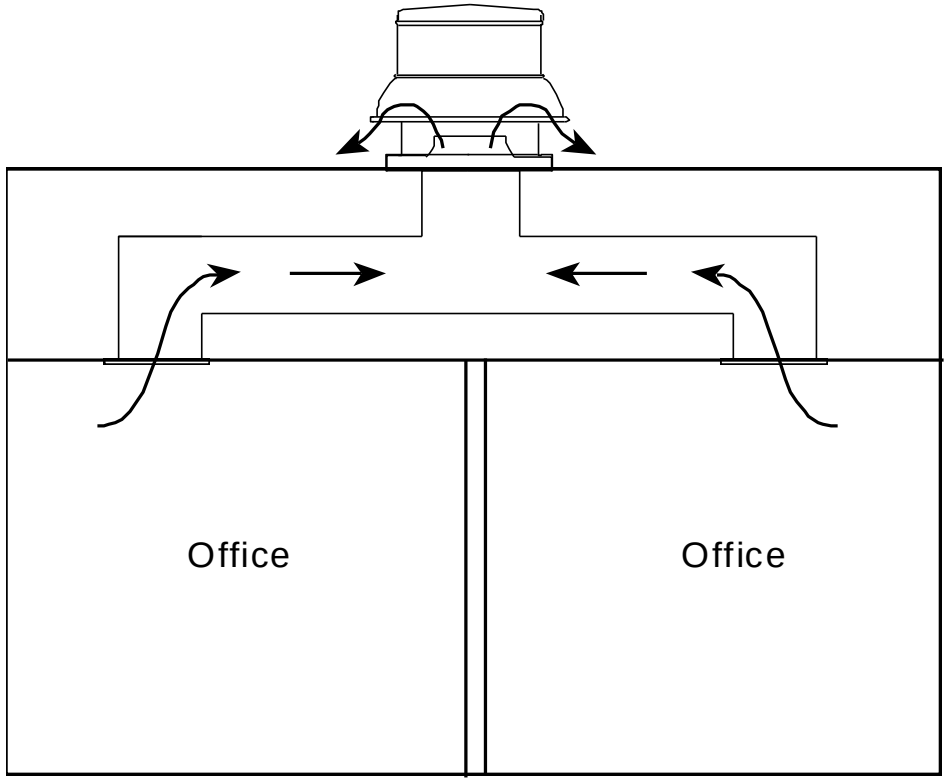
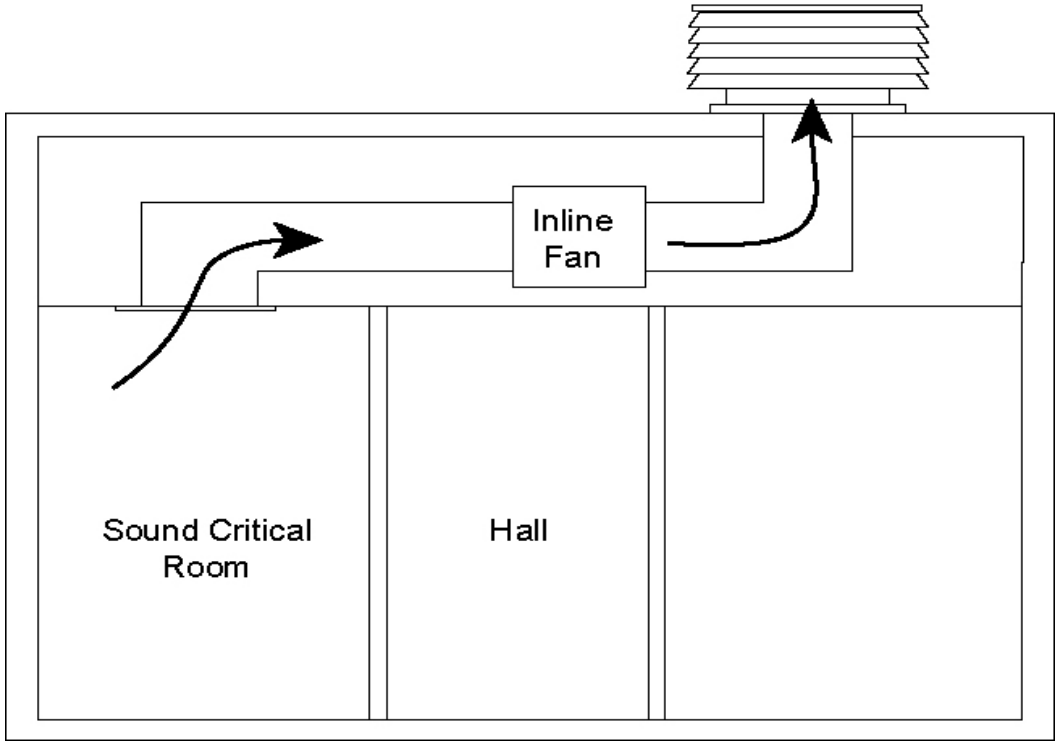
管道式进风，开放式出风 (Type C)



典型的商用通风系统

管道式进风，管道式出风 (Type D)



系 统 效 应

System Effects

系统效应之定义

- 任何置于风机前后足以影响其风机性能之现象

常见的可降低风机与系统(匹配后)性能之状况:

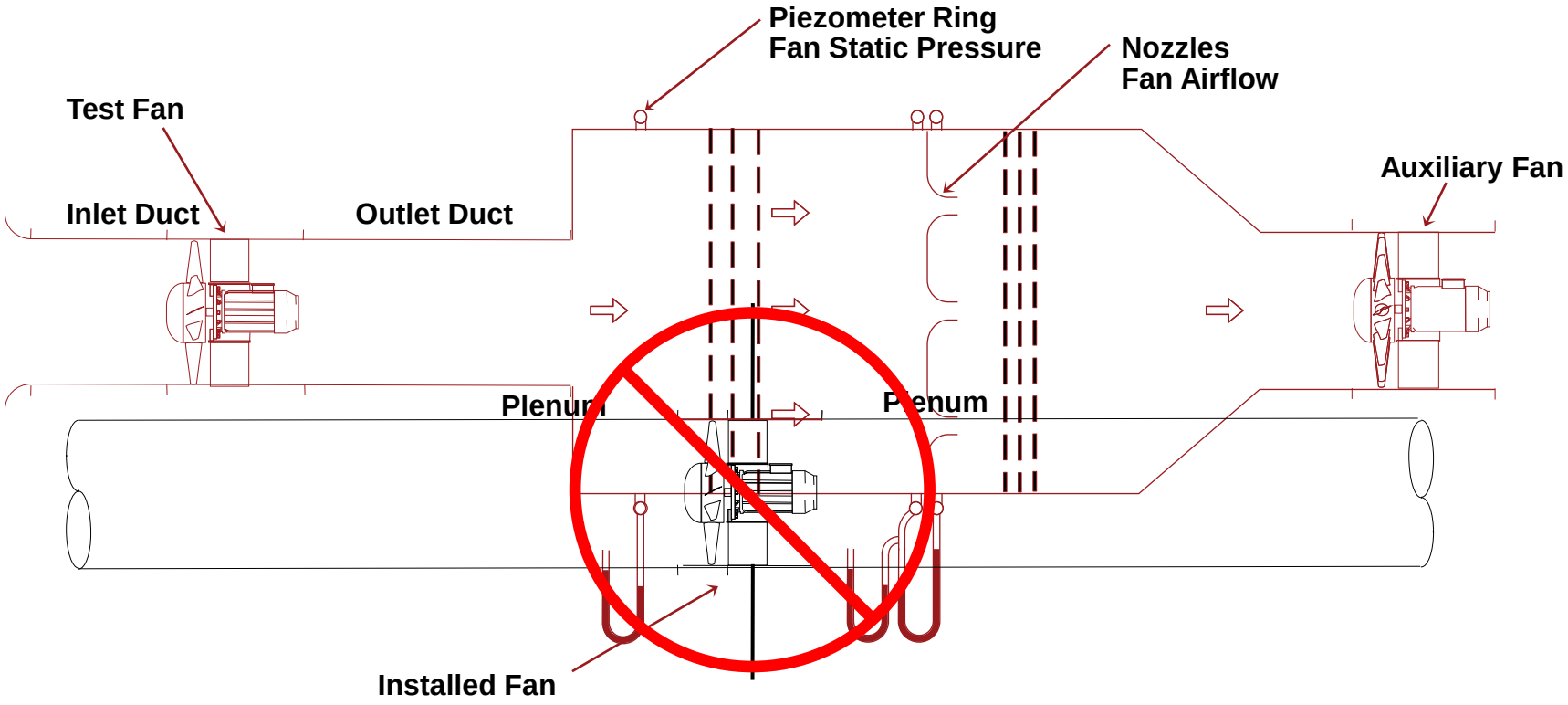
- 不正确的进风、出风连接
- 不规则的进风气流、进风处有涡流
- 设备安装位置的随意性
- 现场风管制作的随意性

系统效应定义 1

安装的风管配置与测试的风管配置不匹配

Installed duct configuration does not match tested duct configuration

型式 D – 管道进风，管道出风

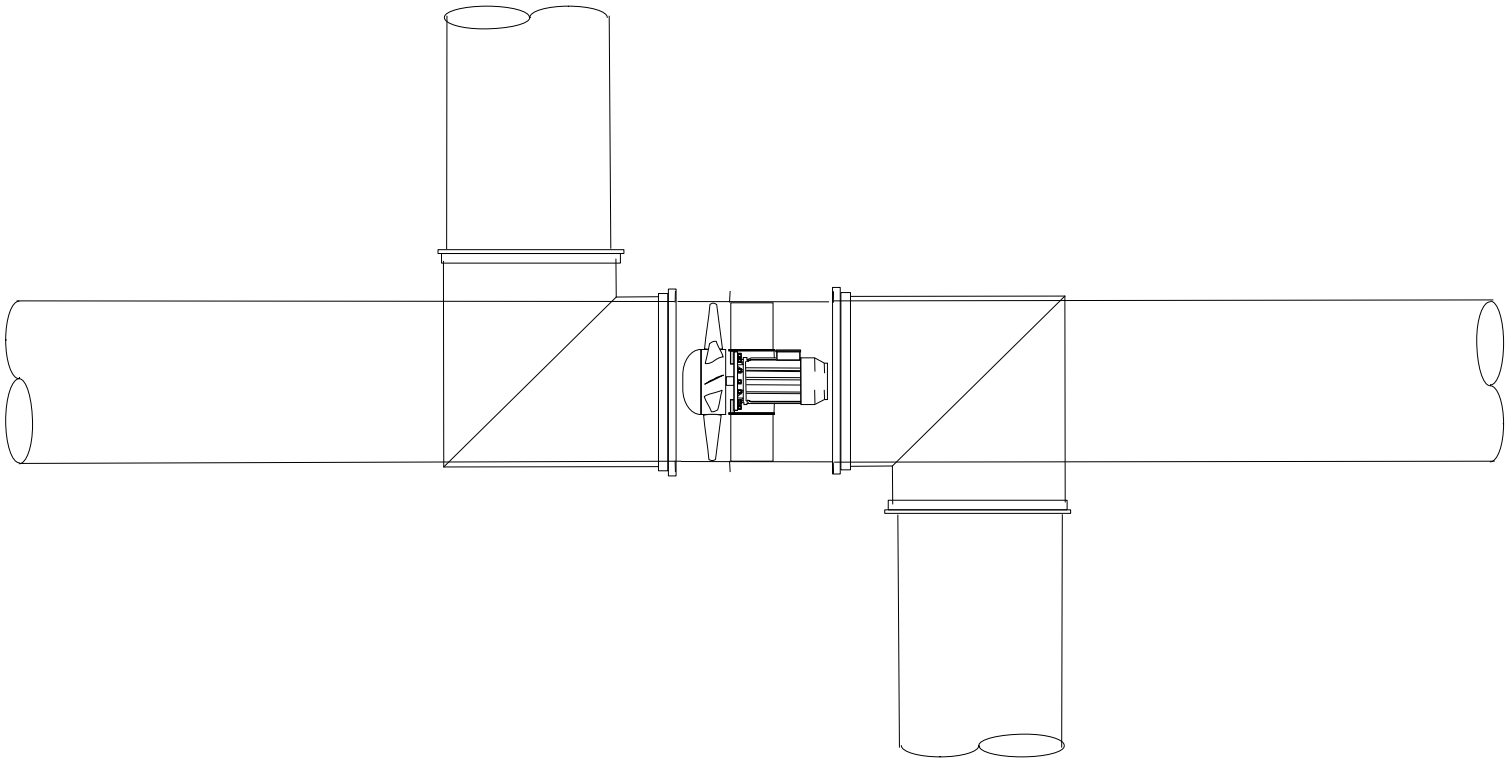


系统效应定义 2

即使当测试的风管配置与安装的风管配置匹配时，错误的风管设计也会导致不利的流动条件

Even when the tested duct configuration matches the installed duct configuration, improper duct design can introduce adverse flow conditions

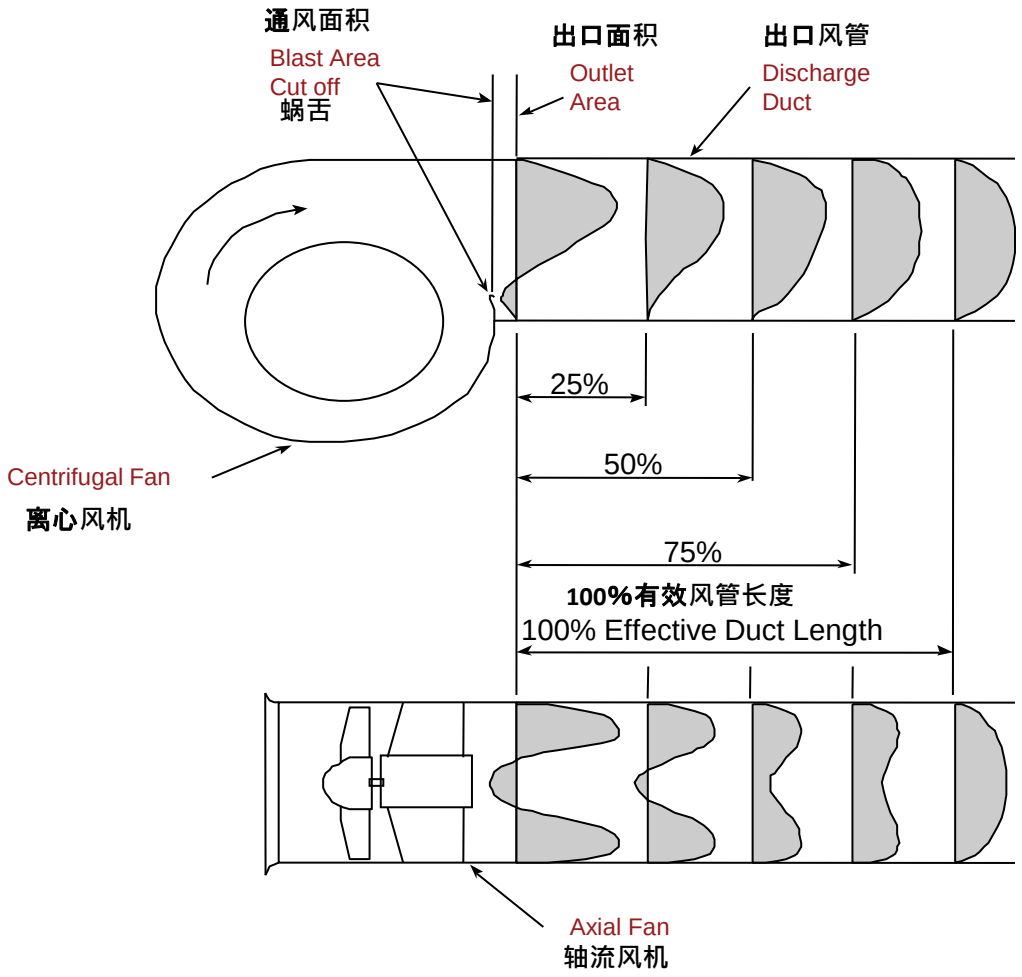
弯管例子



为什么系统效应是重要的

- 可能降低风机性能
- 可能导致额外振动
- 可能导致额外噪音
- 如欲达成所预期的工况点，可能需要更多的能源
- 可能需要更多的时间去了解及决定

风机出风口风速之型态


通风面积
Blast Area
Cut off
蜗舌
出口面积
Outlet
Area
出口风管
Discharge
Duct
25%
50%
75%
100%有效风管长度
100% Effective Duct Length
Centrifugal Fan
离心风机
Axial Fan
轴流风机

有效管长

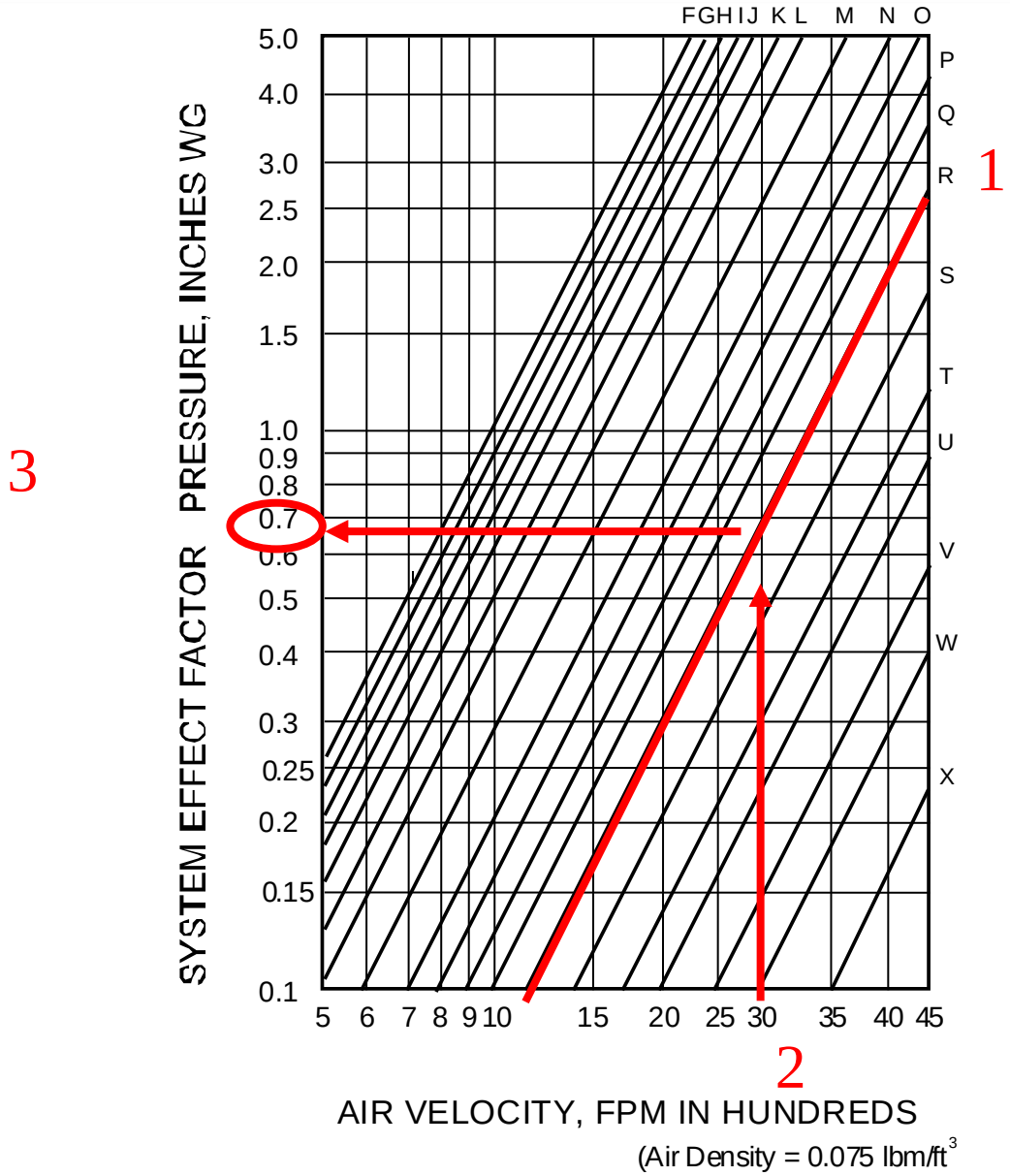
有效管长 = 2.5倍出风口当量直径，

---在风速不高于 12.5m/s时

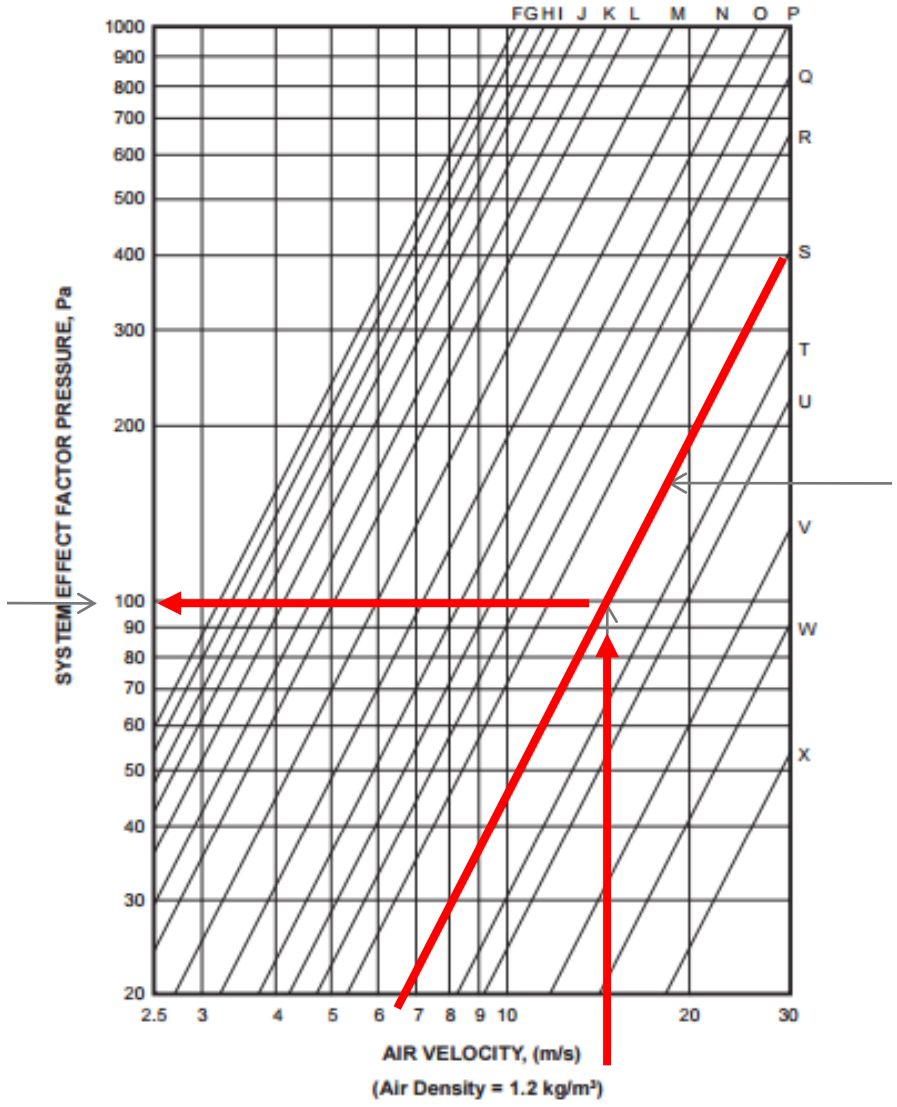
- **风速每增加 5m/s，需增加一个当量直径**
- 对方形管道而言，**当量直径相当于**

(4 x 宽度 x 长度 / 3.14) ^ 0.5

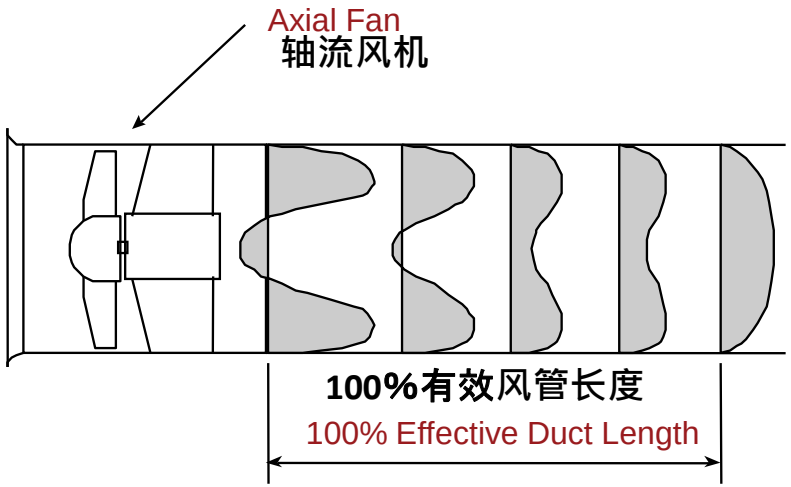
系统效应曲线


FGHIJ K L M N O
P
Q
R
S
T
U
V
W
X
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.25
0.2
0.15
0.1
SYSTEM EFFECT FACTOR PRESSURE, INCHES WG
5 6 7 8 9 10 15 20 25 30 35 40 45
AIR VELOCITY, FPM IN HUNDREDS
(Air Density = 0.075 lbm/ft3
1
2
3

系统效应曲线


F G H I J K L M N O P
Q
R
S
T
U
V
W
X
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
SYSTEM EFFECT FACTOR PRESSURE, Pa
2.5 3 4 5 6 7 8 9 10 20 30
AIR VELOCITY, (m/s)
(Air Density = 1.2 kg/m³)

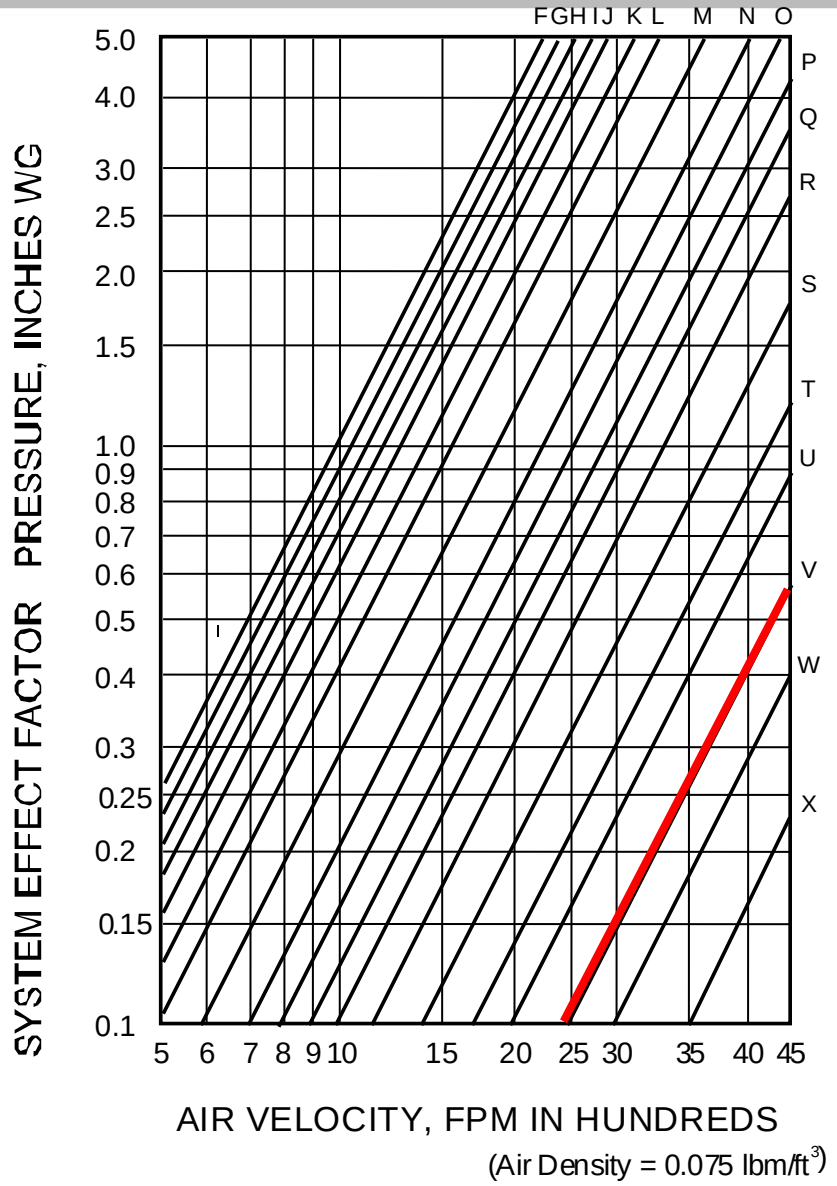
轴流风机出风管道之系统效应



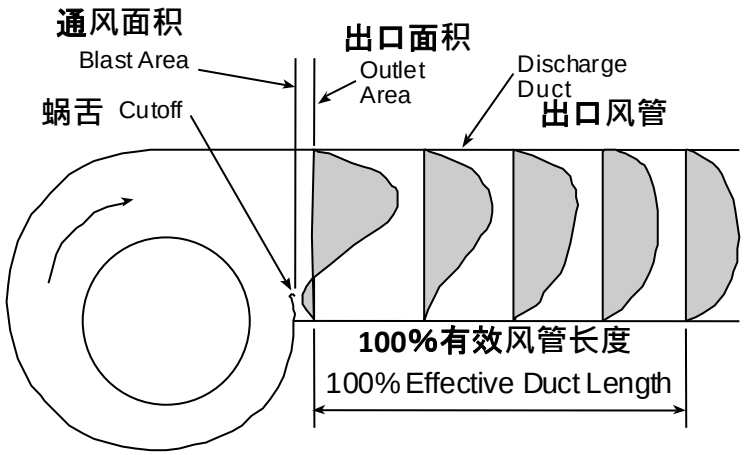
- 100%有效风管长度， 在风速低于12.5m/s 以下时, 不得少于2.5倍的当量直径，每增加5m/s时，应再加一当量直径的管路长度。

	无风管	12% 有效风管	25% 有效风管	75% 有效风管	100% 有效风管
导流式轴流风机	U	V	W	---	---

系统效应曲线


F G H I J K L M N O
P
Q
R
S
T
U
V
W
X
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.25
0.2
0.15
0.1
SYSTEM EFFECT FACTOR PRESSURE, INCHES WG
5 6 7 8 9 10 15 20 25 30 35 40 45
AIR VELOCITY, FPM IN HUNDREDS
(Air Density = 0.075 lbm/ft3)

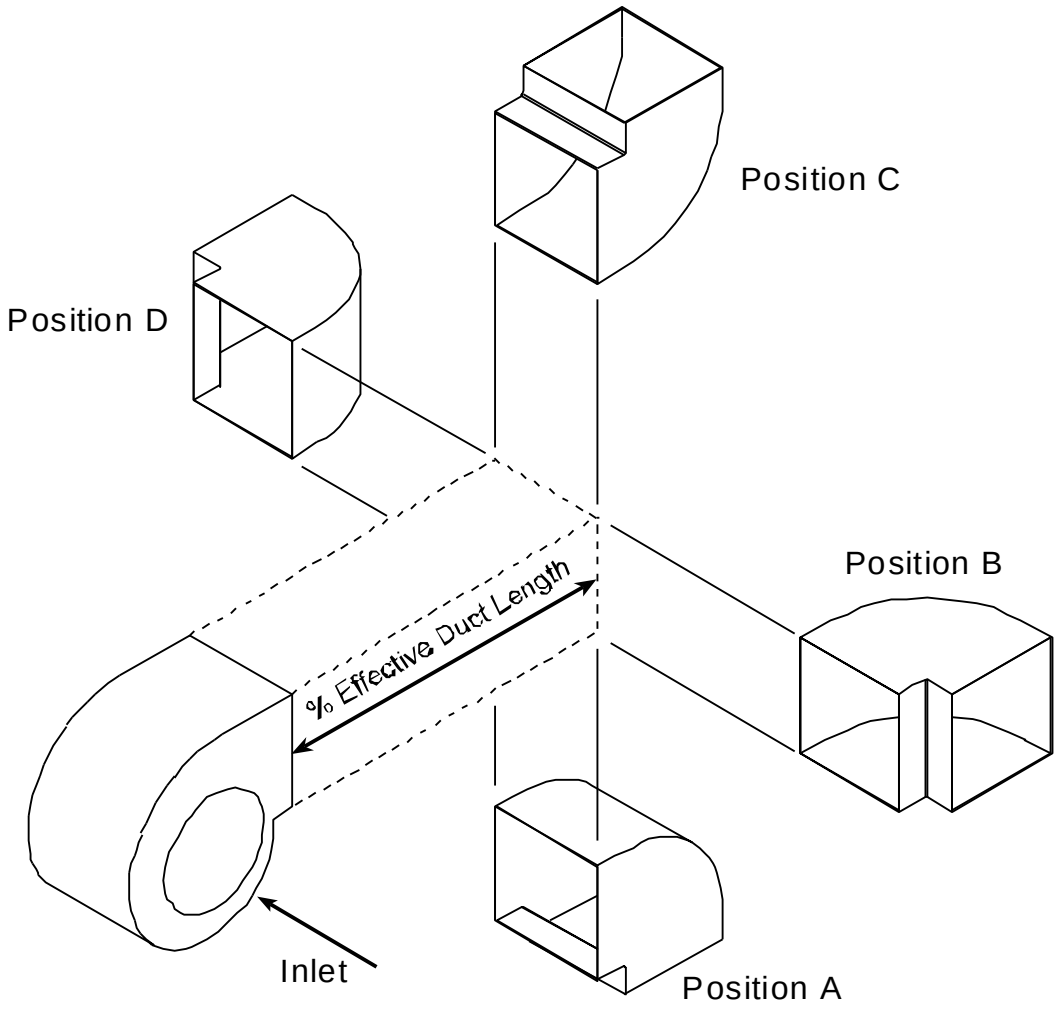
离心风机出风管道之系统效应



- 要达到100%有效风管长度，应包括过渡段的风管至少延长两个半当量直径的管路长度，在12.5m/s以下的出口速度下，每增加5m/s时，应加一当量直径的管路长度。

	无风管	12% 有效风管	25% 有效风管	50% 有效风管	100% 有效风管
静压再获得	0%	50%	80%	90%	100%
通风面积 /出口面积	系统效应阻力曲线				
0.4	P	R-S	U	W	---
0.5	P	R-S	U	W	---
0.6	R-S	S-T	U-V	W-X	---
0.7	S	U	W-X---	---	---
0.8	T-U	V-W	X	---	---
0.9	V-W	W-X	---	---	---
1.0	---	---	---	---	---

离心风机之出口弯头


Position C
Position D
Position B
% Effective Duct Length
Inlet
Position A

单进风风机之系统效应曲线

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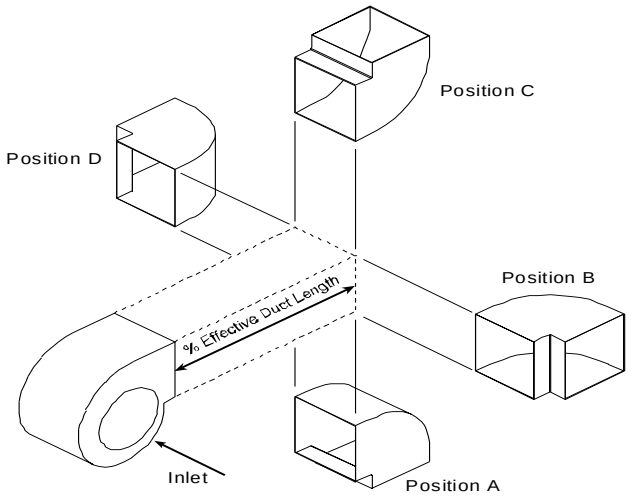
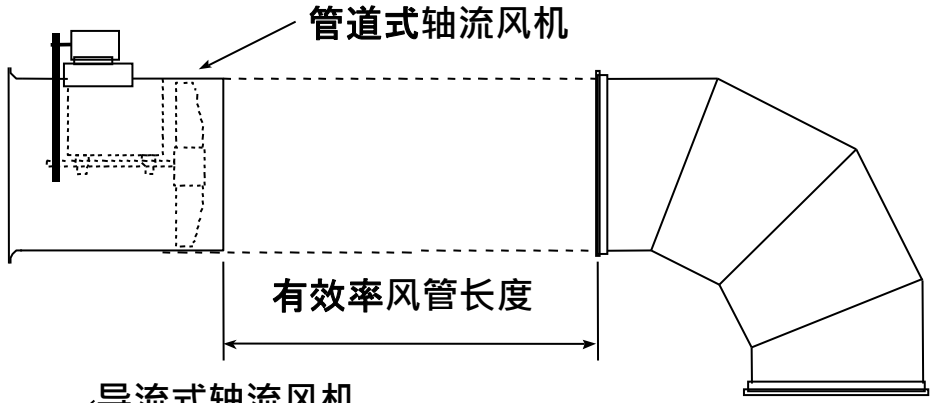
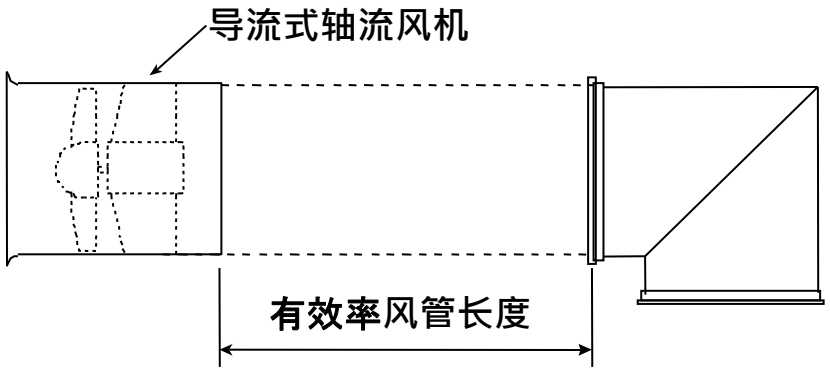
Blast Area / Outlet Area	Outlet Elbow Position	No Outlet Duct	12% Effective Duct	25% Effective Duct	50% Effective Duct	100% Effective Duct
0.4	A	N	O	P-Q	S	
	B	M-N	N	O-P	R-S	
	C	L-M	M	N	Q	
	D	L-M	M	N	Q	
0.5	A	O-P	P-Q	R	T	
	B	N-O	O-P	Q	S-T	N
	C	M-N	N	O-P	R-S	O
	D	M-N	N	O-P	R-S	
0.6	A	Q	Q-R	S	U	S
	B	P	Q	R	T	Y
	C	N-O	O	Q	S	S
	D	N-O	O	Q	S	T
0.7	A	R-S	S	T	V	E
	B	Q-R	R-S	S-T	U-V	M
	C	P	Q	R-S	T	
	D	P	Q	R-S	T	E
0.8	A	S	S-T	T-U	W	F
	B	R-S	S	T	V	F
	C	Q-R	R	S	U-V	E
	D	Q-R	R	S	U-V	C
0.9	A	T	T-U	U-V	W	T
	B	S	S-T	T-U	W	
	C	R	S	S-T	V	F
	D	R	S	S-T	V	A
1	A	T	T-U	U-V	W	C
	B	S-T	T	U	W	T
	C	R-S	S	T	V	O
	D	R-S	S	T	V	R



轴流风机出口弯头之系统效应曲线



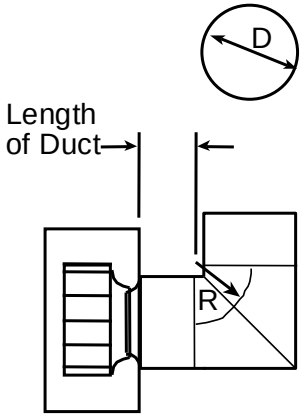


	90# 弯管	无风管	12% 有效风管	25% 有效风管	50% 有效风管	100% 有效风管
导流式轴流风机	2段	U	U-V	V	W	---
导流式轴流风机	4段	W	---	---	---	---

圆形进风管道之系统效应

System Effect Curves

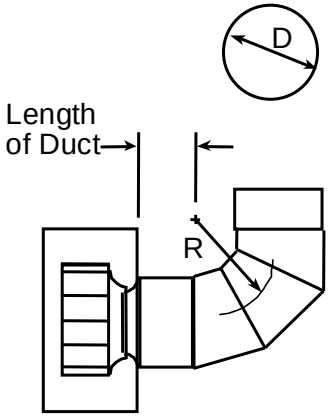
R/D	No Duct	2D Duct	5D Duct
--	N	P	R-S



2 piece mitered round section

System Effect Curves

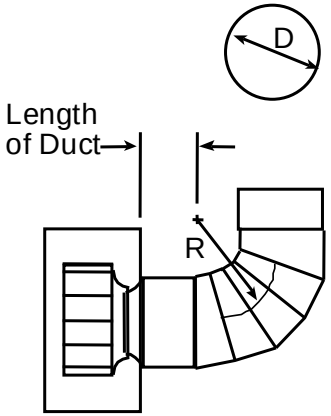
R/D	No Duct	2D Duct	5D Duct
0.5	O	Q	S
0.75	Q	R-S	T-U
1.0	R	S-T	U-V
2.0	R-S	T	U-V
3.0	S	T-U	V



3 piece mitered round section

System Effect Curves

R/D	No Duct	2D Duct	5D Duct
0.5	P-Q	R-S	T
0.75	Q-R	S	U
1.0	R	S-T	U-V
2.0	R-S	T	U-V
3.0	S-T	U	V-W

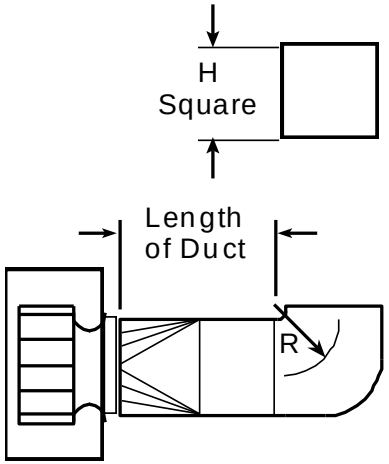


4 or more piece mitered round section

系统效应 —用于弯管与导流板

System Effect Curves

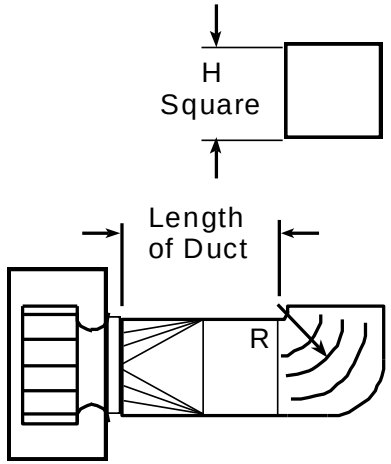
R/D	No Duct	2D Duct	5D Duct
0.5	O	Q	S
0.75	P	R	S-T
1.0	R	S-T	U-V
2.0	S	T-U	V



Square elbow - no turning vanes

System Effect Curves

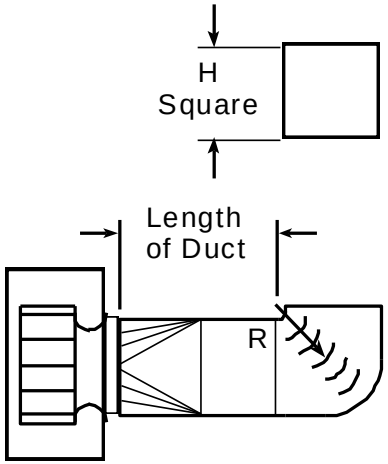
R/D	No Duct	2D Duct	5D Duct
0.5	S	T-U	V
1.0	T	U-V	W
2.0	V	V-W	W-X



Square elbow - long turning vanes

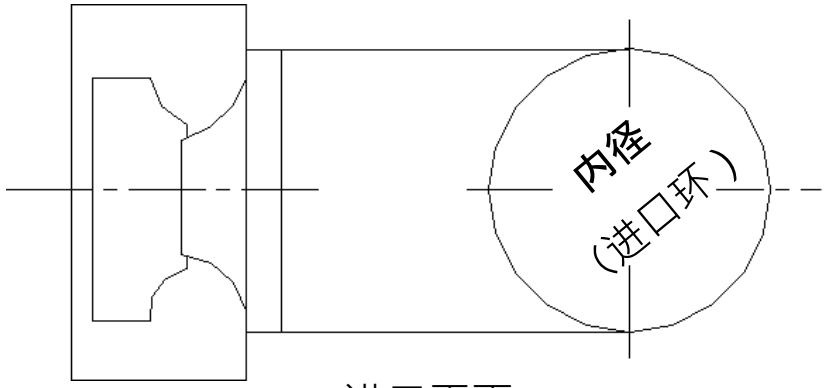
System Effect Curves

R/D	No Duct	2D Duct	5D Duct
0.5	S	T-U	V
1.0	T	U-V	W
2.0	V	V-W	W-X



Square elbow - short turning vanes

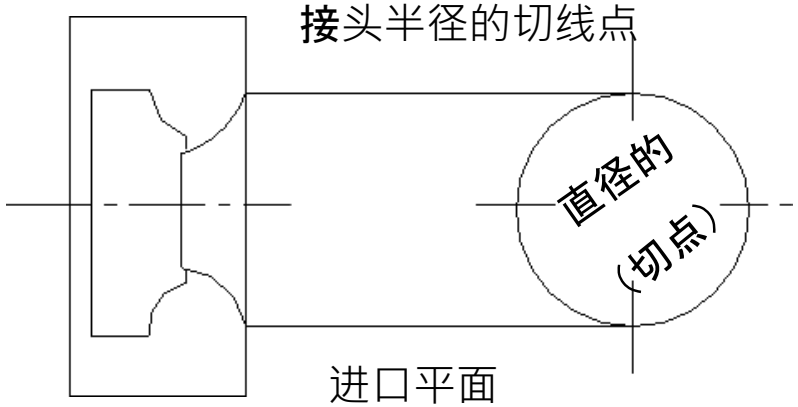
有障碍进口



进口平面

自由进口区平面带进口环的风机

风机侧面和进口锥形
接头半径的切线点

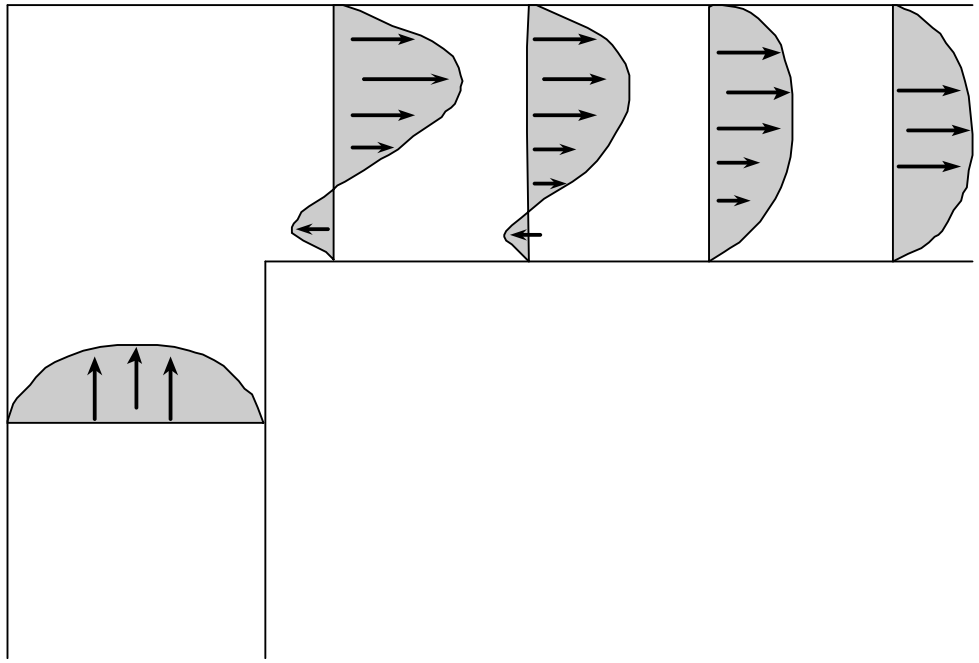


进口平面

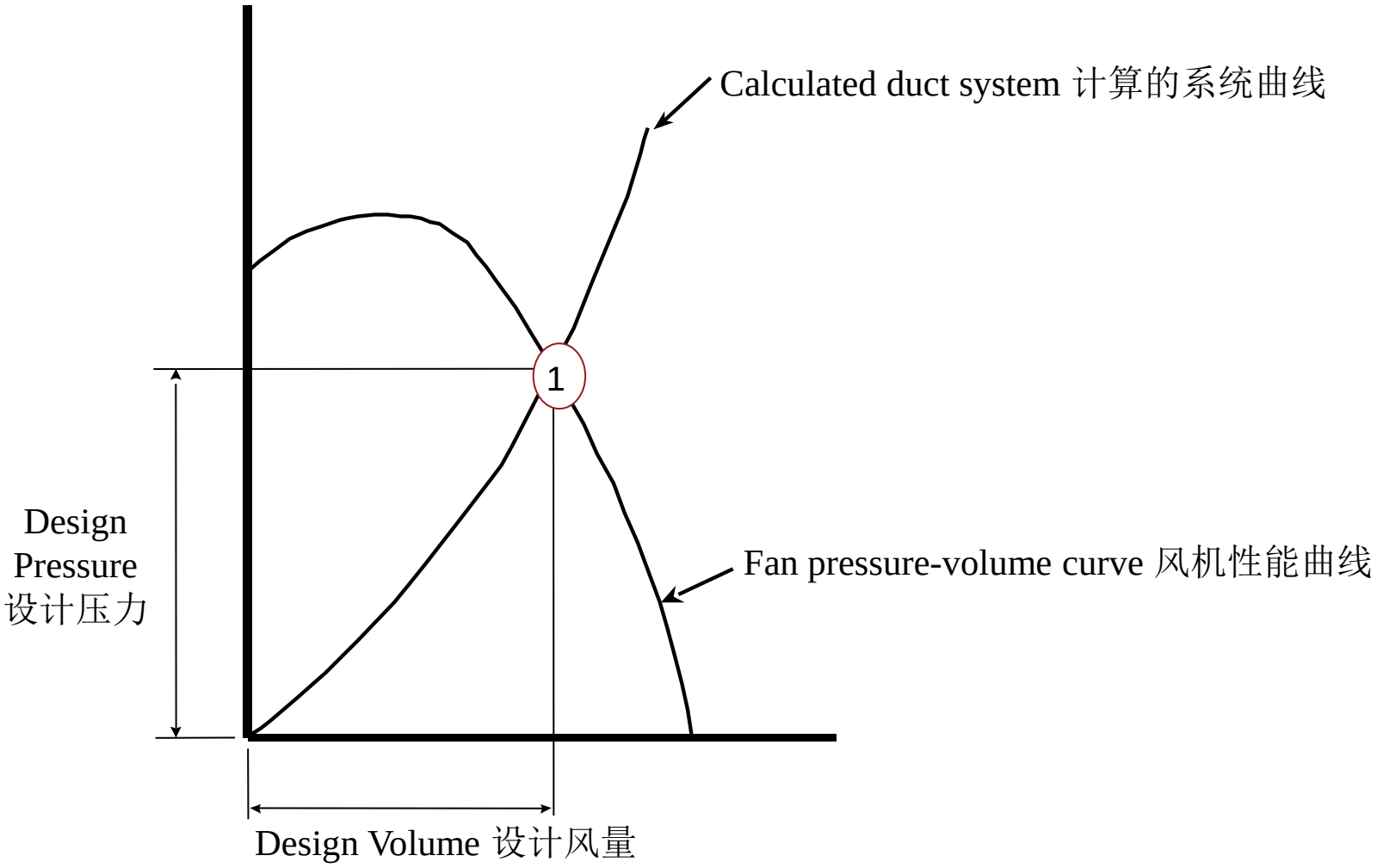
自由进口区平面不带进口环的风机

%无障碍的进口面积百分比	系统效应阻力曲线
100	无损失
95	V
90	U
85	T
75	S
50	Q
25	P

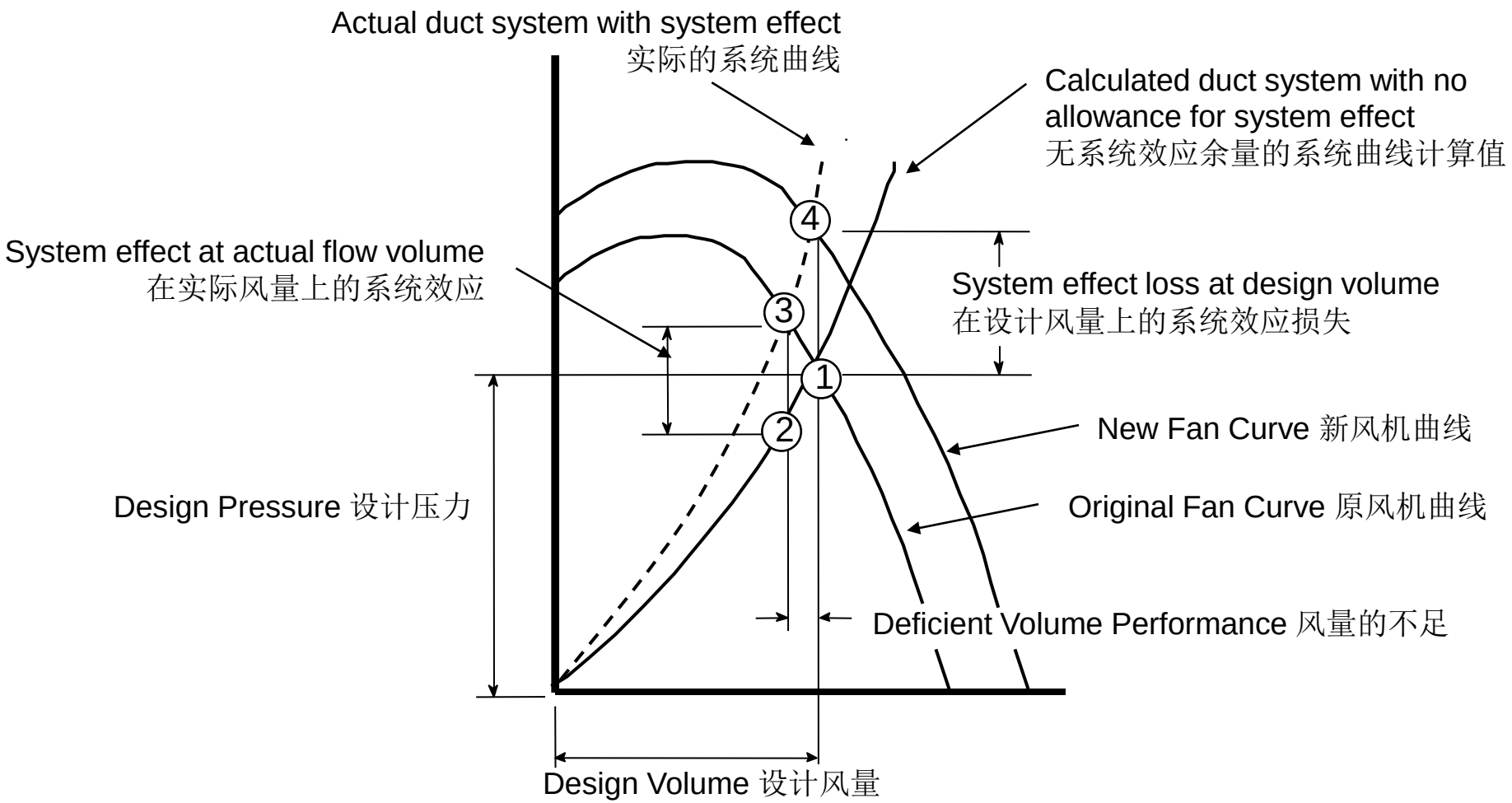
弯管可改变气流之形态



系统效应在工况点上


Calculated duct system 计算的系统曲线
1
Design
Pressure
设计压力
Fan pressure-volume curve 风机性能曲线
Design Volume 设计风量

被忽略了的系统效应


Actual duct system with system effect
实际的系统曲线
Calculated duct system with no allowance for system effect
无系统效应余量的系统曲线计算值
System effect at actual flow volume
在实际风量上的系统效应
System effect loss at design volume
在设计风量上的系统效应损失
4
3
1
2
New Fan Curve 新风机曲线
Design Pressure 设计压力
Original Fan Curve 原风机曲线
Deficient Volume Performance 风量的不足
Design Volume 设计风量

回顾

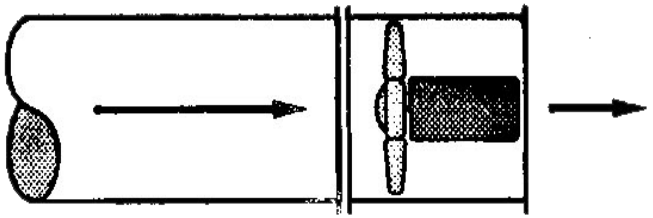
- 在出风口侧，至少2.5倍当量直径
- 在进风口侧，至少5-8倍当量直径
- 避免在进风口侧形成涡流

系统中如有任何因素无法适从上述原则时，务必将这些因素考虑在系统效应之内。

风机出口设计

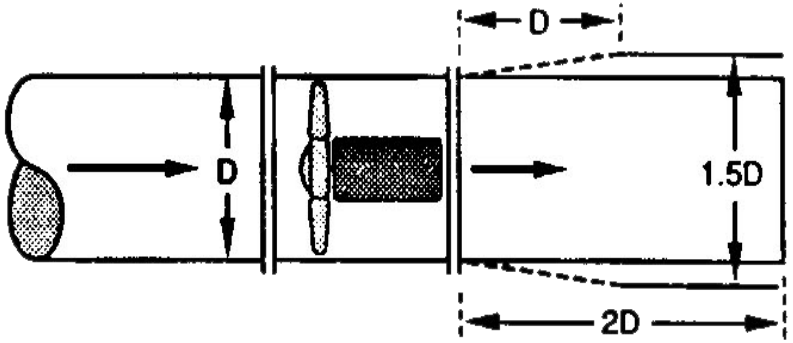
轴流式

不推荐



Avoid having the fan terminate the discharge end of a system.

推荐

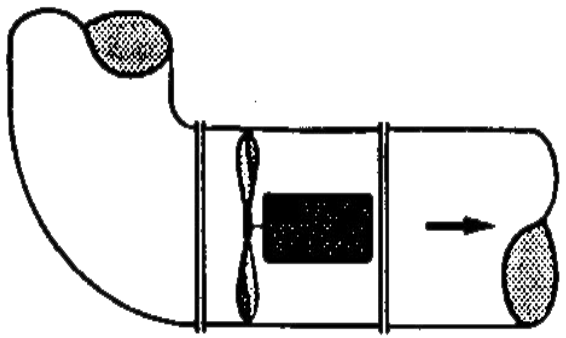


Add a duct length of 2D, or an outlet cone of 1.5D at the discharge end of the fan. Extra ducting after the cone is better.

风机进口设计

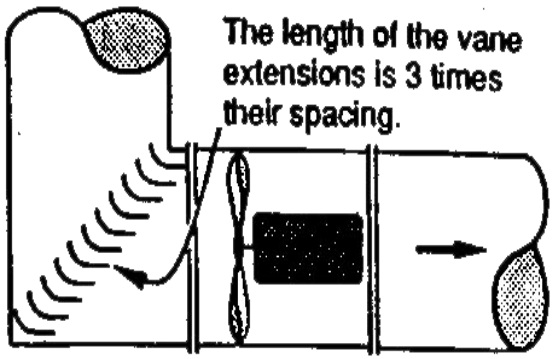
轴流式

不推荐



Upstream radius elbow creates imbalance at inlet.

推荐

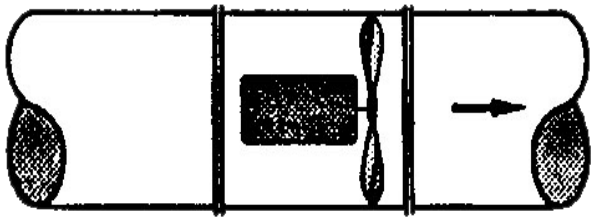


Square inlet elbow with extended trailing edge vanes delivers less turbulent airflow to fan inlet.

风机进口设计

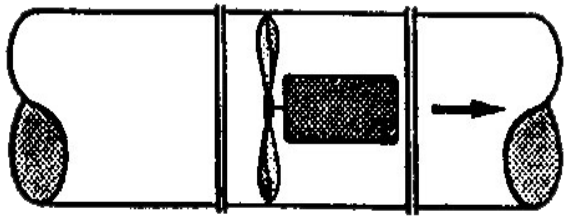
轴流式

不推荐



Motor upstream of impeller increases turbulence and noise.

推荐

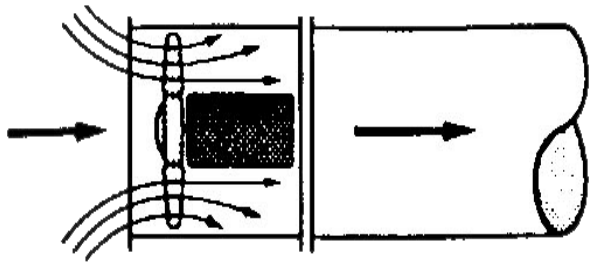


Motor downstream from impeller minimizes turbulence and noise.

风机进口设计

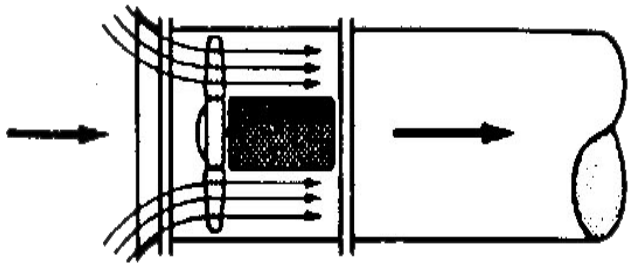
轴流式

不推荐



A flanged fan inlet starves the impeller blade tips of air, reducing performance and increasing noise.

推荐

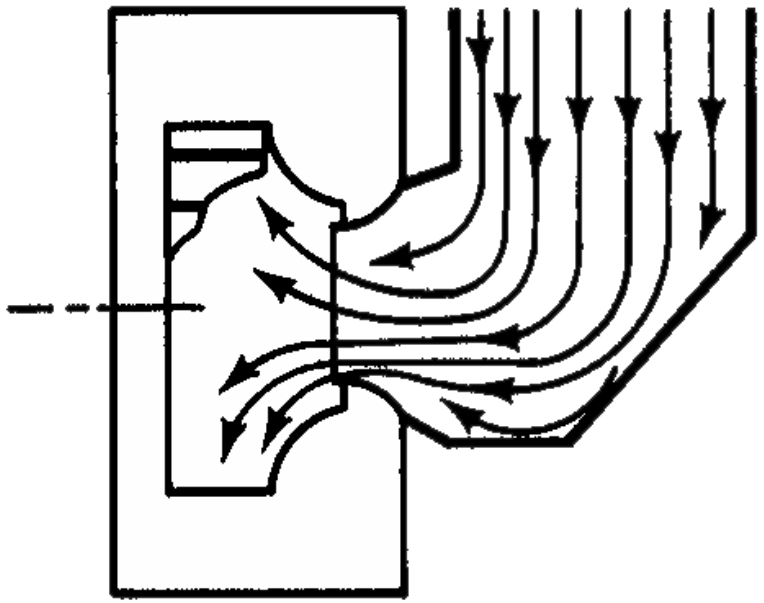


A bellmouth inlet guides air into the impeller blade tips.

风机进口设计

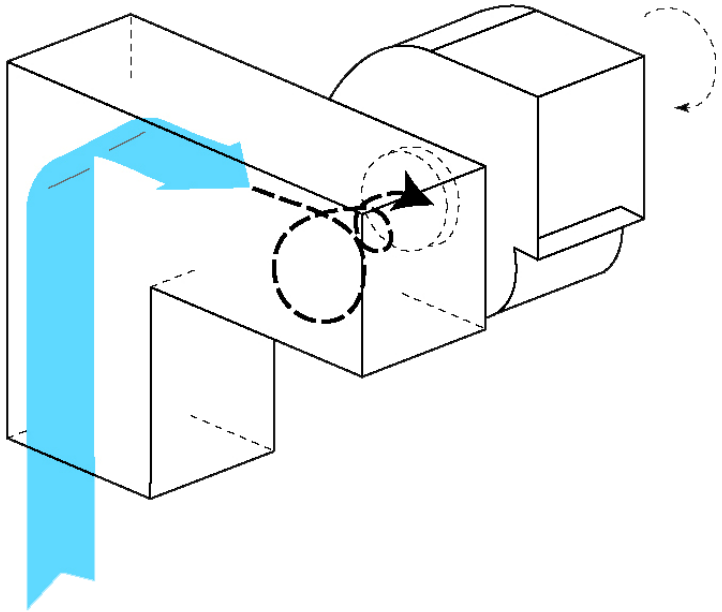
离心式

- 使用特殊设计的进气箱改进进口气流状况

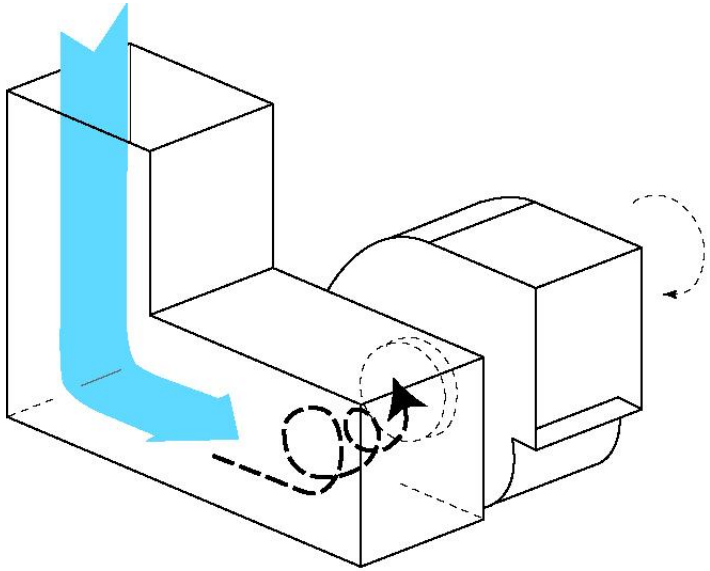


进风涡流

Pre-Rotation

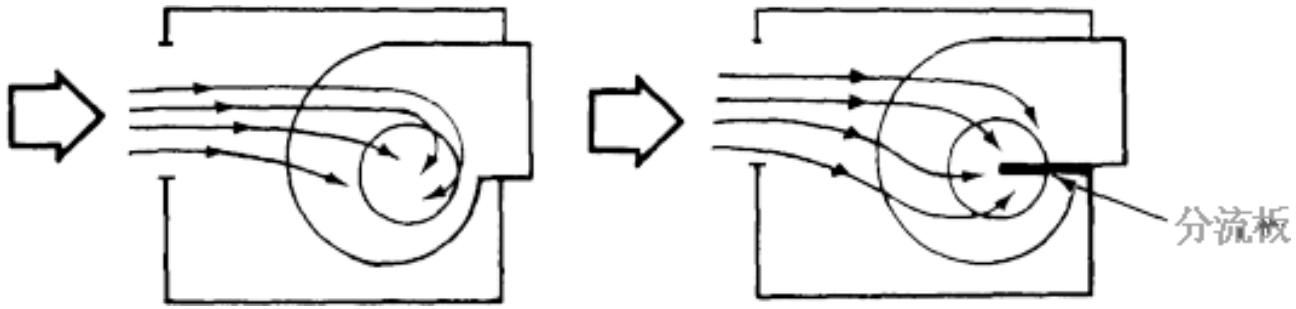


Counter-Rotation

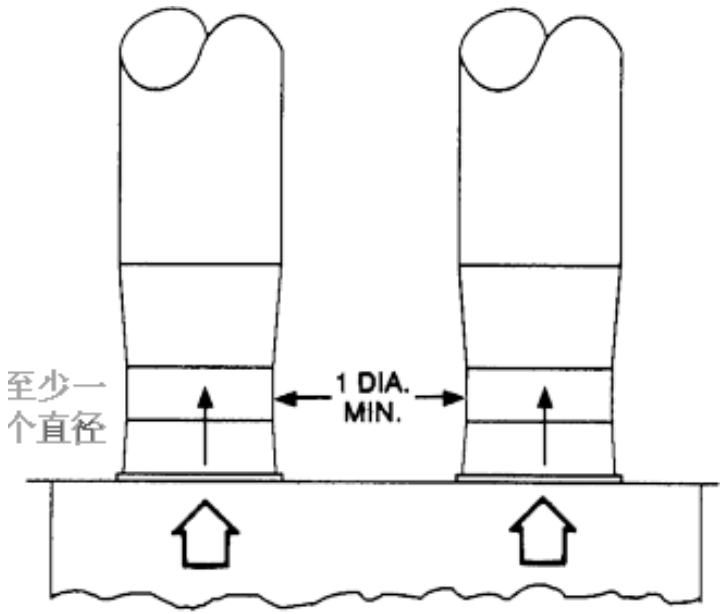


进气箱 •风室效应

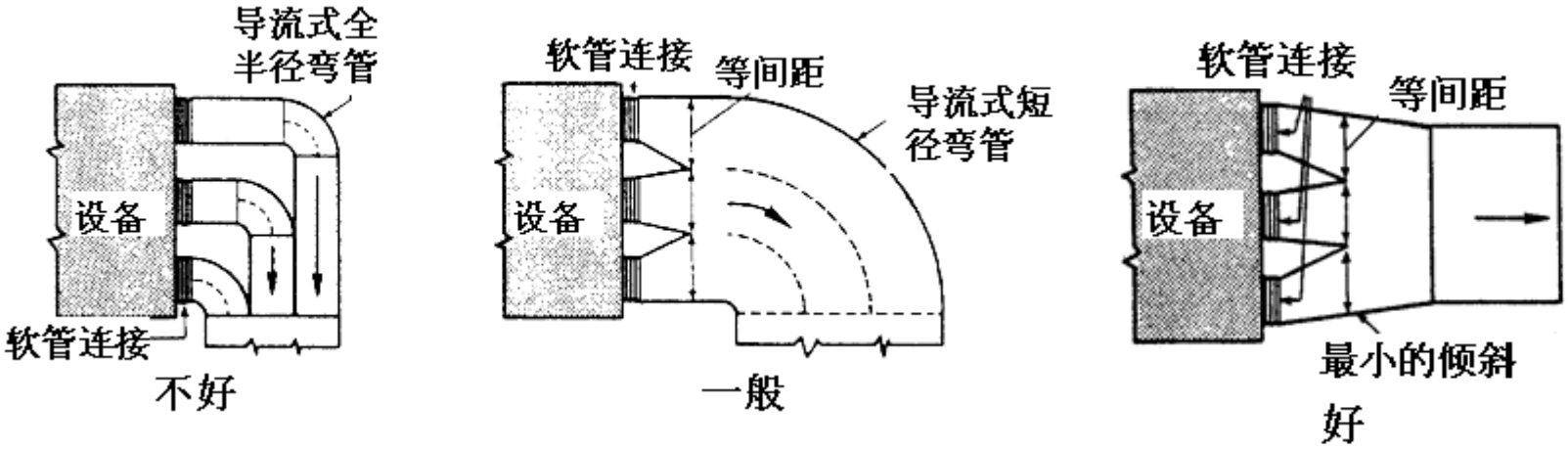
- 进气箱入口与风机进口不对称



- 轴流风机的平行安装



典型的风管连接



如何协助设计师计算管道中的系统效应

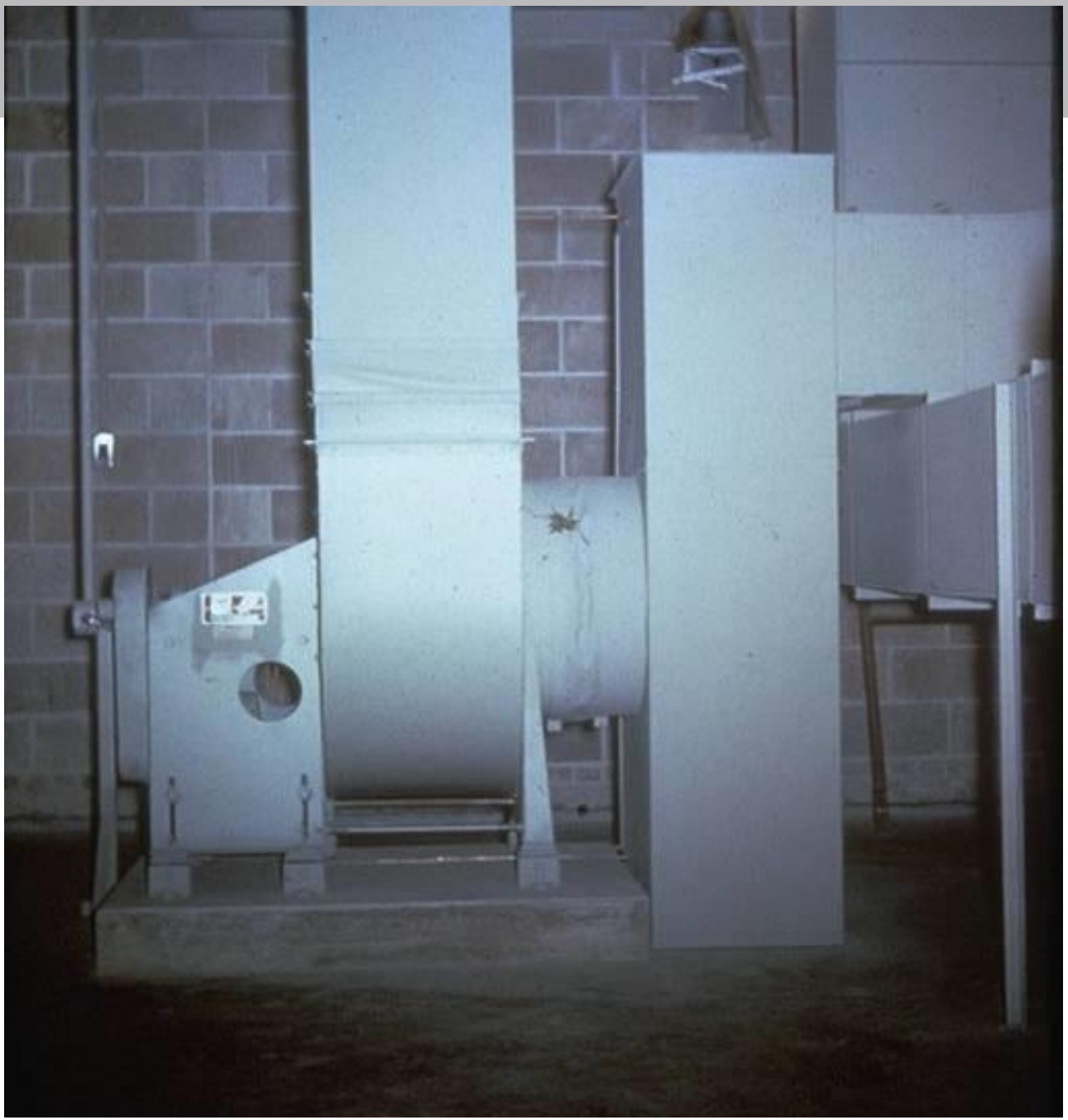
amca INTERNATIONAL

- 具体做法： a)根据设计师提供的工况点参数选型，计算出风机的出口风速；
  b)根据设计师提供的施工图，找出该台风机进出风管实际尺寸；
  c)对照系统效应中不同场景的补偿曲线，在补偿表中查找出相应的补偿值；
  d)根据新的参数，重新选型，得出经补偿系统效应损失后新的运行规格；

- 向设计师提交计算系统效应补偿的过程资料；
- 该过程是一个简单而繁琐工作，需要耐心、仔细！

COOK

03/05/20



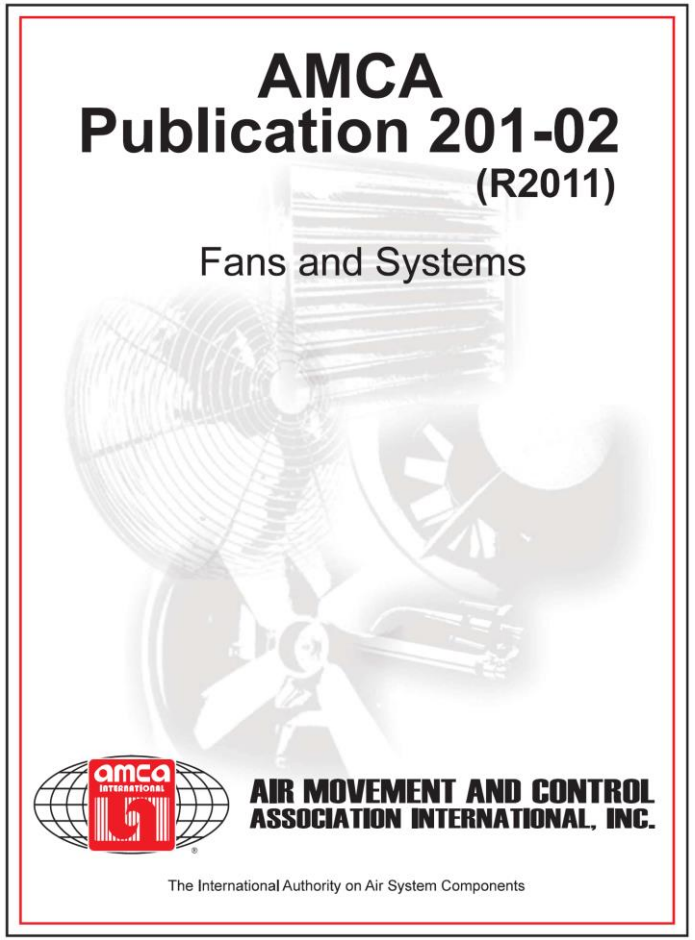
系统效应视频

http://bit.ly/system-effect-zh

资料

- **AMCA International 网页:** *www.amca.org*
- **AMCA inmotion 杂志:** *www.amca.org/educate/#inmotion*
- **AMCA 出版物:** *www.amca.org/store*
- **AMCA 白皮书:** *www.amca.org/educate/#articles-and-technical-papers*

更多有关
系统效应的
资料可参考
AMCA 201
出版物



谢谢